CHAPTER SEVEN
TECHNOLOGY

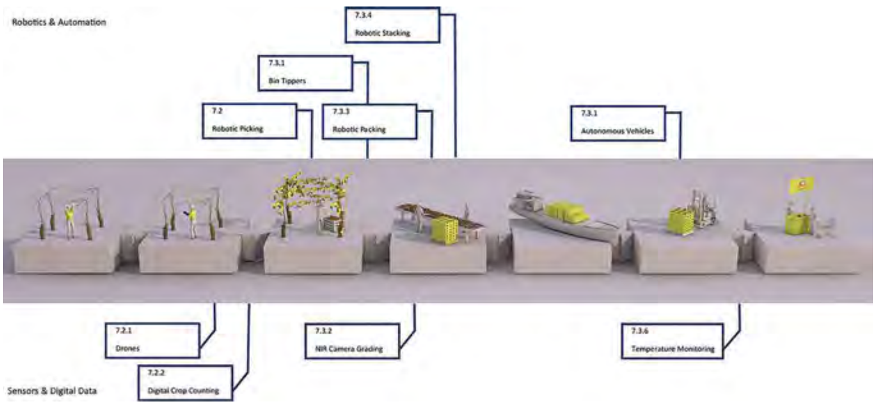
Technology is an incredibly exciting space in horticulture where the industry is working on a number of ideas to improve productivity, address labour constraints and increase output. This chapter will examine the key areas of the supply chain to understand where technology currently is and where it may take us in the future.

THE SECTION IS DIVIDED AS FOLLOWS

7.1 TECHNOLOGY

While technology has always been an important part of the horticulture industry, it is becoming increasingly so. Technology can come in several forms: Robotics and automation are usually introduced in horticulture to drive efficiencies in tasks typically requiring human labour that are either dangerous, dull or dirty. A second form of technology is the increasing use of sensors to measure, monitor or analyse areas of the kiwifruit supply chain where more information, or more accurate information is required. There are several drivers to where technology will take the industry over the coming years, however the key immediate driver is the concern around labour scarcity. New Zealand currently has extremely low unemployment and if continued, will impact upon the ability to help with industry growth aspirations. The kiwifruit industry in the Bay of Plenty alone requires an additional 14,329 people by 2030 in order to harvest and pack the crop based on the current operating systems in place.

Ongoing adoption of technology within the industry, while addressing the immediate concerns around labour shortages, will also enable (and require) an entirely new job market. This market will be one of highly skilled/upskilled labour to build, service and maintain automation technologies, and equally skilled individuals to analyse, interpret and act on the sensor data to improve the efficiency of the kiwifruit supply chain.



Right:
A snapshot of the kiwifruit supply chain from production to consumer highlighting areas discussed further in this chapter

7.2 ON THE ORCHARD

Orchard operations require a lot of labour to maintain. One key activity in the field is harvesting and without labour to help pick the fruit, orchardists could face the threat of their crops rotting on the vine. While there are many different ideas on how harvesting may be automated, the robotic harvesting of kiwifruit is one area that has come a long way in recent years. As robotic harvesters can work night or day without the provisions that traditional labour requires, this technology may become increasingly utilised on orchards in the long term.

Right:
Robotics Plus robotic kiwifruit harvesting autonomous vehicle

7.2.1 Drones, GPS Units and GIS Software

On the orchard, UAV (Drones) can be used to monitor crop conditions, the impact of droughts or floods, and to assess requirements for fertilisation and irrigation. By compiling and digitally analysing records from multiple flights and multiple areas of the orchard over time, UAV technology can help the kiwifruit industry to gain new insights regarding climate change, water resource management and rates of soil erosion.

Under New Zealand's laws, commercial UAVs can be utilised as long as they operate in line of sight of the person controlling them and are flown beneath 120 metres. However, the technology is capable of much more than that: UAVs can be flown from anywhere or pre-programmed to follow a flight path and undertake functions using GPS.

Zespri's use of Drones, GPS Units and GIS Software

All orchards that are allocated a PVR'd variety (Zespri Plant Variety Rights) are subject to an audit by Zespri upon grafting or planting the licenced fruit.

These orchards may also receive random audits over the lifetime of the PVR or when a change to the licenced orchard area has occurred. Zespri contracts GPS-it Limited **www.gpsit.co.nz** to undertake all of the GPS mapping for PVR'd varieties.

GPS-it has carried out the PVR audit programme since its' beginning in 1999. The programme has been improved and refined over time in response to technology and industry changes. The three main technologies used are:

- High accuracy GPS units;
- Drones (UAV) used to capture aerial imagery; and,
- Geographic Information Systems (GIS) software to process and present the maps.

All three technologies have undergone significant advancement over the past 20 years. The accuracy and reliability of GPS units has improved along with an increased number of available satellites, UAV's becoming more commercially popular and GIS software being much more accessible and user-friendly.

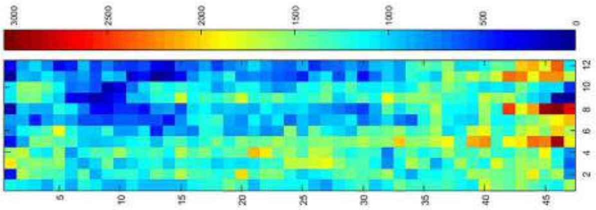
Together they complement each other to produce high accuracy results that are essential for the audit programme, considering the high value of Gold3 orchards and licences. The data produced from this process can be used by Zespri and growers to assist with many important decisions such as PVR enforcement, crop estimation, biosecurity readiness, pest and disease management and more. Growers can also access this data and utilise it to generate precise plans that will help them make important decisions with confidence.

"The accuracy and reliability of GPS units has improved along with an increased number of available satellites, UAV's becoming more commercially popular and GIS software being much more accessible and user-friendly."

7.2.2 Digital Crop Counting Technologies

An area of rapid technology development that is close to commercialisation for use by kiwifruit growers is the use of ground based camera imaging systems. These systems need to be ground based to count what is most important to the industry – flower buds, flowers and fruit. These parts of the kiwifruit vine are hidden from leaves when viewed from above, for example from a drone. Zespri has directly invested in digital crop counting technologies, and a number of other parties are also looking to develop solutions for the industry.

A combination of technologies is reaching the point where they are enabling unprecedented levels of accuracy in counts, and thus information available to the industry to make informed decisions. For a kiwifruit grower, this information (for example a fruit count early in the season) enables them to make informed decisions about their crop management throughout the season to maximise their orchard performance. The same information is of high value to the postharvest suppliers for all manner of operational planning (e.g. Do we have enough coolstore space? How much harvest labour will require?). This same information again is of high value to Zespri to assist it's planning of the coming fruit supply season from New Zealand. Knowing the volume of fruit Zespri has to sell in any season in good time enables Zespri to maximise returns to its growers.



Right:
A visualisation from part of a Zespri Gold3 growers orchard: showing the total fruit counted. Each square is one management area within which orchard management decisions can be made. In this image, over 650,000 individual fruit have been tracked and counted!

7.3 POSTHARVEST OPERATIONS

In the postharvest world, there is also a large amount of labour required to grade and pack the fruit into export pallets of product ready to ship around the world.

7.3.1 Bin Tippers

Firstly, once the bins of fruit arrive from the orchard at the packhouse, the bins of fruit must be emptied into the grading and packing line. The technology that assists with this activity is an automated bin tipper.

Right:
The Sorma bin tipper continuously empties bins autonomously onto the grading line

7.3.2 Near Infrared Camera Grading

Once on the grading line, the latest technology currently being used in the industry is called Near Infrared (NIR) Camera Grading. This technology takes thousands of images of the individual fruit and makes decisions about its size and quality. The model 'Spectrim' is the latest optical sorting technology available in the kiwifruit industry. **http://www.compacsort.com/en/inspectra2/**

Right:
NIR grading machine

How Does NIR Work?

How the NIR cameras work is that they pulse light into fruit and measure changes in wavelengths in rebounded light. NIR can measure the internal qualities of fruit including; dry matter, brix, colour, and pressure. Multiple high-speed cameras capture over 300 high definition images of each piece of fruit as it travels across the grading line. These images are processed across multiple wavelengths to identify internal and external fruit defects, including; blemishes, flat fruit, soft fruit, and sooty mould.

The grading machine then accepts or rejects the fruit and the ones that are accepted are then bumped off the line at the right time to be packed in trays with fruit of the same size and quality.

This was all once undertaken by individuals handling every piece of fruit and the use of this technology has reduced the number of manual graders on an average shift from 20 down to 3.

Measuring Quality and Standards

The primary purpose of NIR technology is to recover fruit which is above dry matter thresholds, from size counts which have failed to meet dry matter requirements. For example, the Minimum Taste Standard (MTS) for Gold3 in 2018 was >70% of fruit sampled met a Dry Matter (DM) level of 16.1% or greater.

Small count sizes generally have lower dry matter and it isn't uncommon for smaller size counts i.e. 36's and 39's to fail MTS. Even though fruit has failed to meet the 70% DM threshold, a percentage of fruit in these size counts will be above 16.1%. Some of this fruit can be recovered as class 1 using NIR technology.

The flesh of gold fruit is green until it matures. Gold must meet colour requirements to achieve harvest clearance i.e. change from green to gold. Fruit is tested using a chronometre. Even when fruit achieves clearance, there will be a percentage which is green, and requires colour conditioning at ambient temperature before it can be accepted into inventory. NIR allows green fruit to be treated separately, making the colour conditioning process more efficient.

Storage Benefits

Another bonus with NIR technology is that it has the potential to see inside the fruit and make better decisions on how long the fruit will last, e.g. should the fruit be sold quickly, or will it last the distance on a ship to Europe? The technology can optimize storage potential by segregating fruit within 'ideal' ranges. For example, a desirable brix range for long storing Hayward (Green) kiwifruit is 8°- 11° at harvest. Fruit outside of the ideal range can be segregated and shipped early, thereby improving the storage potential of fruit within the ideal range.

> "Another bonus with NIR technology is that it can also see inside the fruit and make better decisions on how long the fruit will last, e.g. should the fruit be sold quickly, or will it last the distance on a ship to Europe?"

7.3.3 Automated Packing

Pacmaster

With the kiwifruit industry's projected future growth driven by Zespri's very successful introduction and marketing of G3, there is a significant increase in fruit volume expected to come into production in the next three years. Therefore, an increase of labour will be required to get this volume picked, packed and shipped to Zespri customers around the globe. In 2018, with labour in short supply, Apata Group based in the Bay of Plenty approached their local packhouse solution provider MAF New Zealand to discuss ways to increase efficiency and productivity to pack trays of kiwifruit.

Being able to free up labour from this bottle neck part of the packing process would allow Apata to reposition labour to other areas of their business in order to consistently deliver to the increasing export market.

The Pacmaster follows the development of robotic packing equipment used in the apple, citrus and avocado industries and draws on experience in local semi-automated packing of kiwifruit. As technology has progressed, companies like MAF RODA have applied sensor and robotic componentry to assist with presenting the fruit to the machine in a way where variability is managed. This means that the machine can consistently and accurately pick up the fruit, without dropping them, while also handling each fruit very gently so as to not damage or bruise the product.

The tray packing machine concept was designed collaboratively with Apata, MAF New Zealand and their parent company MAF RODA AGROBOTIC in France. Software development for controlling the machine was completed in Mount Maunganui in collaboration with the MAF Group research and design engineers in France. Testing was completed in the research and design department at MAF RODA, and then sent to the Apata Mends Lane site for installation and commissioning by the MAF New Zealand team.

Unique components of the Pacmaster include inclined conveyors with smart fruit sensing capability, multi-format heads that adapt to the different tray layout and individual suction cups that can lift the fruit and position them into the tray. Further, servo drive pneumatic head assemblies that allow optimised movement of the head from pick up to delivery point, and remote internet connection to France all helped with ensuring the equipment was developed quickly and delivers to the customer's requirements.

The amount of cups used can also be interchangeable depending on the amount of kiwifruit required in the specific tray. These can quickly change: for example depending on size the format may swap from packing 36 fruit a tray to 25 fruit should the packing plan change.

Initial testing on site in the 2019 kiwifruit season showed that the Pacmaster could consistently pack 22 trays of kiwifruit per minute. This is a significant change compared to older tray packing versions at 15 trays per minute or the 3 trays per minute achieved on average by packing staff per outlet on a sizer. This means that the increased productivity being achieved has provided Apata with substantial labour savings, consistent placement of fruit into trays and in the future, the ability to redeploy staff into the orchards to assist with orchard management, shipping, logistics, storage and cold chain as demand increases.

Right:
The Pacmaster

MAF NZ AGRO ROBOTIC

"Initial testing on site in the 2019 kiwifruit season showed that the Pacmaster could consistently pack 22 trays of kiwifruit per minute. This is a significant change compared to older tray packing versions at 15 trays per minute or the 3 trays per minute achieved on average by packing staff per outlet on a sizer."

7.3.4 Robotic Stacking

After grading and being placed into their trays, the fruit then need to be assembled onto pallets and strapped down ready for shipping before they can be put into cool storage. This area is being quickly automated also with what is called palletisation and it is possible already to do this completely without human interference.

Right:
Robotic arms placing full boxes of produce onto pallets ready for coolstorage

7.3.5 Autonomous Vehicles

Forklifts require labour for operation. Autonomous vehicles are being deployed in great numbers globally in a large variety of production and warehousing environments including the horticulture sector. Millions of bins and pallets are moved across the same paths and into similar locations constantly in the packhouse environment which can also be undertaken via the automated fleet.

Right:
A Skilled Group autonomous forklift that moves product without human interference

7.3.6 Temperature Monitoring and Management of Fruit from Coolstore to Market

Much of New Zealand's fruit travels from New Zealand to northern hemisphere markets. Travelling this distance requires careful temperature management, monitoring and adjustment to ensure the fruit arrives in peak condition, closer to eating ripeness to delight kiwifruit consumers. Zespri's quality monitoring programmes include the use of temperature monitors in combination with fruit monitoring by technicians – a combination of sensor data and human judgement to make complicated decisions.

7.4 LIGHTS-OUT COOLSTORE AUTOMATION

The first fully automated coolstore for the kiwifruit industry was opened in May 2019 by EastPack.

An investment of $10m, the new coolstore is termed a 'lights-out' coolstore – it has no people inside it and works with a series of robotics and artificial intelligence to check, move and position pallets of fruit into two rooms, each with a tall tower of racking that reaches 14m or 5 levels high.

The entire structure is 51m by 41m and 18.2m high. It has the capacity to store 1.2 million trays of fruit and was built in response to the huge growth of fruit volume anticipated in the next five years.